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SOIL QUALITY ASSESSMENT THROUGH MINIMUM DATA SET UNDER ARECANUT LAND USE SYSTEM HILLY ZONE OF KARNATAKA, INDIA

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ABSTRACT

With the intensification of agricultural practices to get enhanced returns, there is a new emphasis on using the concept of soil quality. Quantitative assessment of soil quality is done to determine the sustainability of land uses in terms of environmental quality and plant productivity. Arecanut is one of the important commercial crop grown in Shivamogga and Chikkamagaluru areas that falls under hilly zone (Zone-9) of the agro-climatic zone of Karnataka. Twenty-four different physical, chemical, and biological soil attributes were measured for surface soil samples (0-30 cm) in 225 representative samples from different locations of Arecanut growing plantations of Shivamoga and Chikmagaluru districts of Karnataka. The study was conducted to address the selection of most appropriate soil quality indicators and to quantify the soil quality index (SQI) under arecanut land use system in Shivamogga and Chikkamagaluru districts of Karnataka. Principal component analysis (PCA) approach was followed to get the minimum data set on the measured attributes. The data obtained which was subjected to PCA provided seven principal components (PCs) with eigen-values >1 and explaining at least 5 per cent of the variance in the data set. The seven PCs together explained 85.52 per cent of the total variance. Based on the rotated factor loadings of soil attributes, the selected minimum data set were soil organic carbon (SOC) from PC-1, maximum water holding capacity from PC-2, available potassium (K_2O) from PC-3, exchangeable Mg (Mg) from PC-4, sand from PC-5, available boron (B) from PC-6 and earthworm population density (EWPD) from PC-7. Indicators were transformed into scores (linear scoring method) using standard procedures to calculate the SQI. The obtained SQI for Shivamogga was 0.41 and for Chikkamagaluru was 0.43 under arecanut land use system of the hilly zone of Karnataka. The overall contribution (in per cent) in the determination of SQI was in the order of SOC (40.10), MWHC (10.40), K_2O (10.10), Mg (11.19), sand (15.61), B (6.73) and EWPD (5.94).

***KEY WORDS:** Soil Quality Index, Hilly Zone, Are Canut Land Use, Principal Component Analysis & Minimum Data Set*

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Original Article

INTRODUCTION

Arecanut (*Areca catechu L.*)is one of the most profitable commercial plantation crop grown in Karnataka state and is grown in about 2.75 lakh hectares with an annual production of 4.88 lakh tonnes. The Malnad tract mainly comprises of Thirthahalli, Hosanagara and Sagara taluka’s of Shivamogga district and Sringeri, Koppa,

Mudigere & N.R.Pura talukas of Chickmagaluru district that comes under hilly zone (zone 9) of the agro-climatic zone of Karnataka. These two districts contribute 34.65 percent of the total area and 30.21percent of the total production of the state (Anonymous, 2016). Varying parent materials, heavy rainfall, variation in altitude, temperature fluctuations, highly acidic soils, high slope lands, loss of nutrients through leaching, severe topsoil erosion etc. are the characteristics of the above areas (Nirmalaya and Sahu, 1993). These factors may play a dominant role in determining the soil fertility and productivity of the crop.

Soil degradation is a major issue, which is posing a tremendous threat to agriculture sustainability and environment quality (Mandal *et al.*, 2011). Inappropriate land use and soil management practices are the main reasons for severe degradation of agricultural lands in recent times. The success in soil management to maintain soil quality depends on an understanding of how soils respond to agricultural practices over time. For this reason, recent interest in evaluating the quality of soil resources has been adopted by many researchers. Soil quality is defined as "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" (Karlen *et al.*, 1998). Thus, assessing the soil quality index of particular land use and to identify the different soil quality indicators has become an important issue in recent times.

Hence, this study was conducted to assess the soil quality index (SQI) through minimum data set under arecanut land use system of Shivamogga and Chikkamagaluru districts which falls under hilly zone (zone 9) of the agro-climatic zone of Karnataka.

MATERIALS AND METHODS

The study area comprises of Thirthahalli, Hosanagara and Sagara talukas of Shivamogga district, Sringeri, Koppa, N.R. Pura and Mudigere talukas of Chikkamagalur district. About 225 surface samples (0-30 cm depth) from different locations from arecanut plantations of the area were selected for the study. The soil samples collected were analyzed for 24 different physical, chemical, and biological properties by following standard procedures. Mechanical analysis to determine the percent sand, silt and clay content was done by following international pipette method (Piper, 1966). The bulk density (B.D.), maximum water holding capacity (MWHC) and percent porosity were estimated by following Keen's cup method (Bernard Keen and Raczkowshi, 1921).

The soil pH was measured by using pH meter, electrical conductivity (E.C) by conductivity bridge. The soil organic carbon (SOC) was determined by Walkley and Black wet oxidation method. The available nitrogen (N) was estimated by alkaline permanganate method, Bray's available phosphorus (P_2O_5) by Spectrophotometric method, the available potassium (K_2O) by flame photometry, exchangeable calcium (Ca) and exchangeable magnesium (Mg) by versanate titration method and available sulfur (S) by turbidometric method (Jackson, 1973). The DTPA extractable iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were estimated using atomic adsorption spectrophotometric method as outlined by Lindsay and Norwell (1978). The hot water soluble boron was estimated by Azomethane-H method (Berger and Trough, 1984).

Earthworms were sampled by digging soil to a calculated area and the population density (EWPD) was determined by dividing the total no. of earthworms collected in the sampling area by the sampling area (Anderson and Ingrem, 1993). The soil microbial biomass carbon (SMBC) was estimated by chloroform fumigation method (Jenkinson

and Powsson, 1976). The soil dehydrogenase enzyme activity (DHEA) was estimated by the reduction of TTC (triphenyl tetrazolium chloride) to TPF (triphenyl formazan) (Page *et al.*, 1982).

STATISTICAL ANALYSIS

The data were subjected for normality of distribution and ANOVA was performed using SPSS(version 16) to assess the effect of different soil attributes among different districts. A strength of different soil parameters was determined by Pearson's correlation coefficient. For determination of SQI, three steps were followed as developed by Andrews *et al.,* (2002) as follows. (1) Selection of most critical soil quality indicators, i.e. minimum data set (MDS) of indicators that best represents the soil function, (2) scoring of MDS indicators into scores based on their performance of soil functions, (3) integrating of indicator scores into a comparative index of soil quality. For a selection of MDS, principal component analysis (PCA) was performed using SPSS (version 16) (Andrews *et al.,* 2002). Principal components (PCs) are defined as linear combinations of variables that account for maximum variance within the entire dataset. It was assumed that PCS with eigenvalues >1 (Brejda *et al*. 2000) and those that explained at last 5 percent of the variation in the data (Sharma *et al*., 2005) were selected and subjected to varimax rotation to maximize correlation between PCs and the measured attributes (Shukla *et al.,* 2006). Within each PC, the attribute with highest factor loading (positive or negative) or the attribute with highest correlation sum, were selected for further scoring.

Every observation of selected indicators was transformed into scores of 0 to 1 using the linear scoring method. The equations proposed by Karnel Diack and Stott (2001) were used to convert the soil data into scores as follows: y = (x-s) / (1.1*t-s) for 'more is better', y=1-{(x-s) / (1.1*t-s)} for 'less is better', where y is the score of the soil data, x is value of the soil property, s is the lowest value and t is the highest value.

The third step was to calculate the soil quality index (SQI). After transforming the observed values into scores, the indicators were weighted using PCA results. The percentage of variation in the total dataset was divided by the total percentage of variation explained by all the selected PC's gives the weighted factor (W) for attributes selected under a given PC. The SQI was calculated using the formula SQI $=\sum_{i=1}^{n} WiSi$, where W is the weighting factor derived from PCA, S is the indicator score. Higher scores of SQI indicates better soil quality and vice versa.

RESULTS AND DISCUSSIONS

The estimated values of the soil samples indicated that the soils were sandy loam sandy clay loam in texture with low bulk density. The soils were medium to slightly acidic with low salinity and high organic carbon status. The soils were medium in available N and K, low in available P_2O_5 and good in micronutrients status. The data on the mean values of different soil attributes of the two districts with standard deviation are presented in table 1. It is clear that the soils attributes showed significant differences between two districts within arecanut land use system.

It is difficult to comprehend the effect of different attributes on overall soil quality by looking at a large number of variables at a time. Thus, the correlation matrix of 24 soil attributes was carried out and was presented in table 2. It is evident that the soil attributes has a tendency to respond in groups between the two districts under arecanut land use system. Therefore, to facilitate the easy understanding of the dataset, a large number of soil properties could be divided, based on their correlation patterns in a small number of uncorrelated groups containing correlated attributes. Thus, to reduce the redundancy of the data, PCA was performed on the measured soil attributes. The results of PCA showing PCs with their eigen values and proportion of variance (in per cent) explained along with the rotated factor loadings and

communalities are presented in table 3. The PCA provided 7 PCs with eigen value > 1 and explaining at least 5 per cent of the variance in the data set. The 7 PCs together explained 85.52 percent of total variance. Based on the rotated factor loadings from PCA, the selected MDS were SOC from PC-1, MWHC from PC-2, Available K from PC-3, exch. Mg from PC-4, sand from PC-5, available B from PC-6 and EWPD from PC-7.

Under PC-1, SOC and SMBC were the two attributes with the highest factor loadings of 0.938 and 0.921, respectively. Since these two were highly correlated, only SOC was retained in the PC-1. It explained 28.15 percent of total variance with an eigenvalue of 6.76. The importance of SOC as the strongest indicator of soil quality, as observed in this study, is frequently reported by Brejda *et al.* (2000); Liu *et al.* (2006); Shukla *et al.* (2006). This maybe attributed to the role of SOC in regulating multiple functions in soil that are important soil fertility and soil quality point of view (Singh *et al*., 2013).

In PC-2, MWHC was the selected soil attribute with the highest factor loading of 0.959. It accounted for 16.62 percent of total variance with an eigenvalue of 3.99. The water retention capacity of any given soil is dependent on the adsorptive force of clay and percent pore space which may be due to high organic matter content and the vegetative cover under arecanut land use (Rangaswamy and Murthy, 1978). The available K was the selected soil attribute from PC-3. It accounted for 12.03 percent of total variation with an eigenvalue of 2.83. Since arecanut requires a lot of potassium for better crop quality and yield, and potassium is one of the primary nutrient element in mineral nutrition of plants, might have resulted in retaining as MDS from PCA in the soil quality assessment.

Exch. Mg was the selected soil attribute from PC-4 with a factor loading of 0.874. It accounted for 9.20 percent of total variance with an eigenvalue of 2.20. Since these were based unsaturated acidic soils, the magnesium plays an important role in maintaining soil quality of the region. Sand was the selected physical soil attribute selected from PC-5 with a negative factor loading of -0.942. It accounted for 7.79 percent of total variance with an eigenvakue of 1.51. In many studies, soil textural components- sand, silt, and clay are being reported as a component of MDS indicators (Brejda and Moorman, 2001, Cho *et al*., 2004).

Likewise, available B from PC-6 and EWPD from PC-7 were the selected attributes as MDS from PCA. They accounted for 6.28 and 5.28 percent of total variation with eigen values of 1.51 and 1.03, respectively. Boron, being an important micronutrient element, has a major role in ascertaining the soil quality of the area. EWPD was the only biological attribute selected as MDS from the analyzed PCA.

The relationship between eigen value and principal component was depicted through screw plot as shown in Figure 1. From the above PCs, ‘more is better’ approach was followed for all soil attributes except for sand where ‘less is better approach’ was followed to compute the scores using the formula which was explained earlier. The individual scores from each PCs from all observations were multiplied by the weighting factor derived from PCA to obtain the soil quality index under arecanut land use between the two districts. The weighting factor for the selected MDS varied from 0.329 for PC-1, 0.194 for PC-2, 0.141 for PC-3, 0.108 for PC-4, 0.093 for PC-5, 0.073 for PC-6 and 0.061 for PC-7. The SQI assessed by the linear scoring method under arecanut land use for Shivamogga was 0.41 ± 0.10 and 0.43 ± 0.07 for Chikkamagalur district (Figure 2).

The SQI of both the districts fell under the low category (Low=SQI < 0.50) as per classification is given by Xu *et al.*, (2006). The lowest SQI rating for Shivamogga and Chikkamagaluru may be attributed to the exhaustive nature of the

arecanut crop combined with geological and climatic characteristics of the hilly region. The overall contribution of different PCs in the determination of SQI was in the order of SOC– 40.02%, MWHC – 10.40%, K – 10.10%, Mg – 11.19%, sand – 15.61%, B – 6.73% and EWPD– 5.94%. The results of SQI clearly indicated that the values for arecanut of Shivamogga and Chikkamagaluru were on par with each other. The SOC, the water retention capacity, available K content, exch. Mg, sand proportion, the avl. B and the earthworm population density played a major role in determining the SQI. Sumita Chandel *et al.* (2018), Singh *et al.* (2013) were reported that SQI of forest and grassland use systems were more than that of horticultural and cultivated land use systems, in their earlier studies.

CONCLUSIONS

From the present study, it can be concluded that seven different soil attributes (indicators), *viz*: sand and MWHC from physical attributes; SOC, K, Mg, and B from chemical attributes; and EWPD from biological attributes were identified, which reliably explain the soil quality of the study area. The SQI of both the districts: Shivamogga and Chikkamagaluru fell under low category and on par with each other. Hence, there is a wide scope for improving the SQI by managing the identified attributes and introducing more appropriate management techniques. These can be achieved by supplying a high amount of organic matter, avoiding top-soil erosion and nutrient leaching, amelioration of the soil with calcium and magnesium-rich liming materials, appropriate and adequate application of plant nutrients, *etc.* in both the districts, which represents major are canut growing areas of the hilly zone of Karnataka.

REFERENCES

1. *Andrews, S. S., Karlen, D.L.and Mitchell, J. P. 2002. A comparison of soil quality indexing methods for vegetable production systems in northern California. Agriculture, Ecosystems & Environment,* ***90:*** *25–45.*
2. *Anderson, J.M. and Ingram, J.S.I. 1993. Tropical soil biology and fertility – a handbook of methods(2nd edn.) Wallingford, UK: CAB Internatinal.*
3. *Anonymous. 2016. Horticultural crop statistics of Karnataka state at a glance. Horticulture Department, Govt. of Karnataka, pp. 58.*
4. *Bernard A.Keen and Henry Raczkowski. 1921. The relation between the clay content and certain physical properties of a soil. Journal of Agricultural Science, 11:441-449.*
5. *Brejda, J. J.and Moorman, T. B., Karlen, D.L., Smith, J. L. and Dao, T. H. 2000. Identification of regional soil quality factors and indicators: 1.Central and southern hill plains. Soil Science society of America Journal, 64:2115-2124.*
6. *Cho, K. M., Zoebisch, M. A. and Ranamukhaarachchi, S. L. 2004. Land use dependent soil quality in the Lam Phra Phloeng watershed, northeast Thailand, paper no. 119. In: 13th international soil conservation organization conference on "Conserving soil and water for society: sharing solutions" held in Brisbane, July 2004.*
7. *Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India (Pvt.) Ltd., New Delhi.*
8. *Jenkinson, D.S. and Powlson, D. S. 1976. The effect of biocidal treatments on metabolism in soils. V.A. method of measuring soil biomass. Soil Biology and Biochemistry, 8: 208-213.*
9. *Patel, J. B., & Das, A. M. A. R. E. S. H. (2015). Assessing toxic metals contamination in soil, water and plant bodies around an industrial belt. International Journal of Research in Applied, Natural and Social Sciences, 3(2), 5-20.*
10. *Karlen, L.D. and Stott, D.E. 1994. A framework for evaluating physical and chemical indicators of soil quality. In: Defining soil quality for a sustainable environment. Soil Science Society of America, Special publication, 35: 53-72.*

11. Veeranna, G., & Srijaya, T. Soil Test Based Fertilizer Recommendations For Targated Yields Of Rabi Maize (Zea Mays) In Vertisols Of Telangana State.

12. Karlen, D.L., Gardener, J.C. and Rosek, M.J. 1998. A soil quality framework for evaluating the impact of CRP. Journal of Production Agriculture, 11:56-60.

13. Lindsy, W.L. and Norwell, W.A. 1978, Development of DTPA soil test for zinc, iron, manganese and copper. Soil Sci. Soc. Am. J.,42: 421-428.

14. Liu, X., Herbert, S.J., Hashemi, A.M., Zhang, X. and Ding, G. 2006. Effects of agricultural management on soil organic matter and carbon transformation-a review. Plant, Soil and Environment, 52 (12):531-543.

15. Mandal, U.K., Warrington, D.N., Bharadwaj, A.K., Bar-Tal, A., Kautsky, L., Minz, D. 2008. Evaluating impact of irrigation water quality on a calcareous clay soil using principal component analysis. Geoderma, 144: 189-197.

16. Nirmalaya and Sahu, G. C., 1993, Characterization and classification of soils on hill slopes of middle Andaman Island. Journal of Indian Society Soil Science, 41(1): 133-137.

17. Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of soil analysis (Part II). American Society of Agronomy and Soil Science Society of America, Wisconsin, USA: Madison.

18. Piper, C. S. 1966, Soil and Plant Analysis. Univ. Adelaide, Australia, p.362.

19. Patel, P. H., Patel, N. P., & Patel, P. L. Wavelet Based Analysis Of Soil Nutrients Of Surendranagar District, Gujarat, India.

20. Rangaswamy, P and Murthy, G. S. P. K. 1978. Physical properties of some ferruginous soils in modification of soil structure. Chichester. No. 225-231.

21. Sharma, K.L., Mandal, U.K., Srinivas, K., Vittal, K.P.R., Mandal, B. and Grace, J.K. 2005. Long-term soil management effects on crop yields and soil quality in a dryland Alfisol. Soil and Tillage Research, 83:246-259.

22. Shukla, M.K., Lal, R. and Ebinger, M. 2006. Determining soil quality indicators by factor analysis. Soil and Tillage Research, 87:194-204.

23. Singh, A.K., Bordoloi, L. J., Kumar, M.H. and Parmar, B. 2013. Land use impact on soil quality in eastern Himalayan region of India. Environmetal monitoring and Assessment, 185: 314-325.

24. Sumita Chandel, Hadda, M.S. and Mahal, A.K. 2018. Soil quality assessment through minimum data set under different land uses of Submontane Punjab. C0mmunications in Soil Science and Plant Analysis, https://doi.org/10.1080/00103624.2018.1425424.

25. Xu, M., Zhao, Y., Liu, G. and Argent, R.M. 2006. Soil quality indices and their application in the hilly loess plateau region of China. Australian Journal of Soil Research, 44:245-254.

APPENDIES

Table 1: Physical, Chemical and Biological Properties as Influenced by Arecanut Land Use System

Sl. No.	Soil Attribute	Shivamogga		Chikkamagaluru	
		Mean	Std. Dev.	Mean	Std. Dev.
1	pH (1:2.5)	5.87	±0.26	5.72	±0.33
2	E.C. (dS m^{-1}) ±	0.10	±0.03	0.08	±0.03
3	S.O.C. (g kg^{-1})	13.30	±3.30	14.60	±2.20
4	C.E.C.(c mol(p^+)kg^{-1}	11.05	±0.39	11.25	±0.62
5	Avl. N (kg ha^{-1})	364.47	±34.67	343.14	±31.82
6	Avl.P_2O_5 (kg ha^{-1})	16.47	±3.73	14.09	±1.29

Table 1: Contd.,

7	Avl.K_2O (kg ha^{-1})	188.45	±27.42	187.36	±47.02
8	Ex.Ca (c mol(p^+)kg^{-1}	3.50	±0.54	3.13	±0.57
9	Ex.Mg(c mol(p^+)kg^{-1}	1.63	±0.44	1.55	±0.33
10	Avl. S (mg kg^{-1})	10.64	±2.89	8.67	±3.78
11	DTPA Fe (mg kg^{-1})	34.51	±6.71	37.20	±7.01
12	DTPA Mn (mg kg^{-1})	18.90	±4.82	16.86	±2.85
13	DTPA Cu (mg kg^{-1})	15.36	±4.17	15.05	±4.93
14	DTPA Zn (mg kg^{-1})	0.69	±0.38	1.01	±0.50
15	Avl. B (mg kg^{-1})	0.64	±0.09	0.61	±0.11
16	Sand (%)	58.74	±3.86	59.65	±3.63
17	Silt (%)	19.64	±4.62	19.63	±2.85
18	Clay (%)	21.68	±2.48	20.55	±2.19
19	Bulk Density(Mg m^{-3})	1.48	±0.02	1.47	±0.02
20	MWHC (%)	29.65	±0.53	29.95	±0.72
21	Porosity (%)	43.96	±0.43	44.14	±0.58
22	EWPD(individuals m^{-2})	93.33	±36.63	92.80	±21.06
23	SMBC ((ug g^{-1} soil)	417.76	±110.85	443.62	±73.20
24	DHEA(ugTPFg^{-1}soil day^{-1})	32.73	±6.31	32.11	±2.80

Table 2: Correlation among Soil Attributes Under Arecanut Land Use System

	pH	EC	SOC	CEC	N	P2O5	K2O	Ca	Mg	S	Fe	Mn	Cu	Zn	B	Sand	Silt	Clay	BD	MWHC	Porosit	EWPD	SMBC
EC	**.645****																						
SOC	-0.337	**-.641****																					
CEC	**.535***	0.413	-0.129																				
N	-0.034	0.070	-0.028	0.036																			
P2O5	**.658****	**.486***	**.509***	0.317	0.306																		
K2O	**.546****	**.615****	-0.341	**.481***	-0.018	0.296																	
Ca	**.660****	**.766****	**.483***	**.510***	0.073	**.648****	**.660****																
Mg	**.488***	**.624****	**.498***	**.465***	-0.027	**.636****	**.500***	**.806****															
S	0.386	-0.061	0.014	0.117	0.141	**.593****	0.059	0.214	0.219														
Fe	-0.202	-0.236	0.197	-0.053	**-.472***	-0.317	-0.248	0.073	0.116	-0.034													
Mn	0.289	0.080	0.062	0.143	-0.234	0.340	0.124	**-0.469**	-0.350	**.455***	**.524***												
Cu	-0.408	**-.634****	0.379	**-.469***	0.356	-0.352	-0.384	**-.631****	**-.802****	-0.003	-0.253	-0.215											
Zn	0.045	0.144	0.079	0.192	-0.356	-0.185	**.551****	0.332	0.211	-0.271	0.258	0.383	-0.199										
B	0.084	-0.238	0.389	-0.045	-0.001	-0.060	**.473***	-0.144	-0.126	0.389	**.481***	0.330	0.095	-0.361									
Sand	0.095	0.126	-0.126	**.542****	0.131	0.053	-0.021	0.019	0.067	0.081	-0.219	-0.406	-0.227	-0.321	0.037								
Silt	-0.163	-0.214	0.305	**-.513***	-0.166	-0.239	-0.103	-0.197	-0.113	-0.029	0.304	0.315	0.205	0.248	0.183	**-.788****							
Clay	0.178	0.218	-0.300	0.075	0.087	0.320	0.263	0.347	0.114	-0.028	-0.132	0.168	-0.011	0.103	-0.297	-0.230	-0.405						
BD	0.171	0.239	-0.096	0.050	0.380	0.236	-0.186	-0.035	0.003	0.002	-0.334	-0.038	0.044	-0.113	0.090	0.194	-0.040	-0.188					
MWHC	-0.025	-0.188	0.163	0.068	-0.308	-0.052	0.231	0.205	0.117	0.007	0.328	0.171	-0.144	0.224	-0.161	-0.288	0.035	0.325	**-.903****				
Porosity	0.094	-0.115	0.226	0.122	-0.182	0.105	0.210	0.316	0.206	0.000	0.291	0.277	-0.211	0.283	-0.168	-0.369	0.072	0.391	**-.644****	**.908****			
EWPD	0.332	0.068	0.159	0.227	0.220	0.329	0.005	0.200	0.124	**.424***	-0.026	0.236	-0.131	-0.065	0.125	0.101	-0.134	0.056	0.225	-0.025	0.168		
SMBC	-0.346	**-.647****	**.960****	-0.157	0.018	**-.457***	-0.417	**-.475***	**-.458***	0.124	0.221	0.121	0.369	-0.010	**.464***	-0.106	0.306	-0.340	-0.038	0.103	0.183	0.249	
DHEA	-0.284	**-.458***	0.413	**-.466***	-0.149	**-.520***	**-.481***	**-.559****	**-.579****	-0.012	0.240	-0.031	**.518***	-0.137	**.576****	-0.124	0.384	**-.424***	0.069	-0.268	-0.393	**-.424***	0.406

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Table 3: The Results of Principal Component Analysis and Communalities to Evaluate the Soil Quality Index

	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	Communalities
pH	0.397	-0.052	0.506	0.588	-0.149	-0.058	0.083	0.795
E.C.	0.734	-0.214	0.458	0.062	-0.119	0.006	0.101	0.822
S.O.C.	**0.938**	0.076	0.031	0.039	0.085	0.092	0.130	0.920
C.E.C.	0.132	0.032	0.550	0.195	-0.629	0.119	0.241	0.826
Avl. N	0.004	-0.232	-0.152	0.136	-0.051	0.410	0.340	0.624
Avl.P_2O_5	0.618	0.014	0.062	0.582	-0.030	-0.232	0.359	0.908
Avl. K_2O	0.371	0.207	**0.836**	0.038	-0.053	-0.166	-0.033	0.912
Exch. Ca	0.629	0.164	0.501	0.309	-0.032	0.149	0.293	0.879
Exch. Mg	0.664	0.052	0.318	**0.874**	-0.077	0.336	0.329	0.814
Avl. S	-0.011	0.041	-0.059	0.205	-0.030	-0.079	0.136	0.794
Exch. Fe	-0.139	0.203	-0.131	0.061	0.209	-0.640	0.008	0.866
Exch. Mn	0.062	0.119	0.231	0.532	0.448	0.426	0.241	0.795
Exch. Cu	-0.548	-0.042	-0.285	0.006	0.275	-0.583	-0.283	0.879

Exch. Zn	-0.042	0.130	0.749	-0.304	0.328	0.248	0.058	0.844
Avl. B	-0.359	-0.230	-0.309	0.629	-0.003	**0.861**	-0.094	0.850
Sand	0.013	-0.256	-0.036	0.014	**-0.942**	0.007	0.012	0.954
Silt	-0.251	-0.119	0.075	0.021	0.832	0.217	-0.122	0.838
Clay	0.394	0.526	0.002	0.011	0.081	-0.340	0.164	0.581
B.D.	0.077	-0.874	-0.003	0.032	0.031	-0.198	0.299	0.901
MWHC	-0.070	**0.959**	0.107	-0.002	0.036	0.173	0.009	0.967
Porosity	-0.066	0.858	0.165	0.019	0.138	0.139	0.313	0.905
EWPD	-0.140	-0.036	0.039	0.316	-0.095	-0.064	**0.790**	0.760
SMBC	0.921	0.019	-0.063	0.119	0.092	0.120	0.208	0.933
DHEA	-0.504	-0.319	-0.230	0.160	0.222	0.146	-0.642	0.917
Eigen values	6.76	3.99	2.89	2.21	1.91	1.51	1.03	
Variance (%)	28.15	16.62	12.03	9.20	7.97	6.28	5.28	
Cum.Variance (%)	28.15	44.76	56.79	65.99	73.96	80.24	85.52	

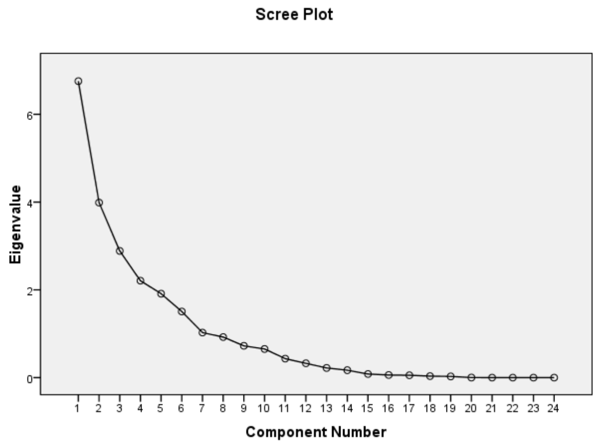

Figure 1: Screw Plot Showing the Relationship Between Eigen Values and the Principal Components

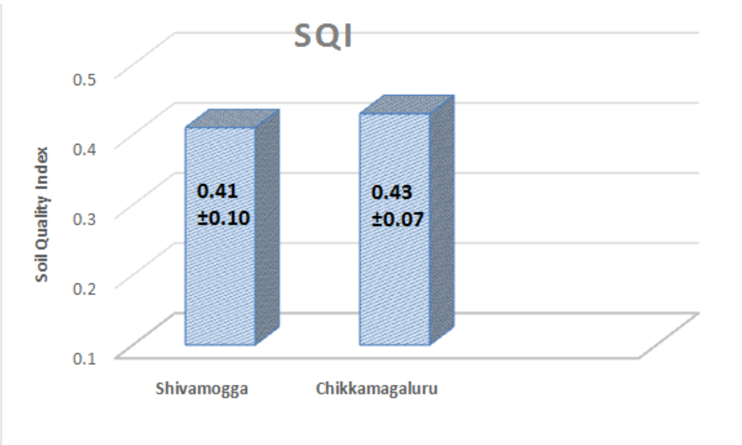

Figure 2: Soil Quality Index of Shivamogga and Chikkamagaluru Districts under Arecanut Land use